

Remarks:

Reconsideration of the application is requested.

Claims 1-23 and 43-46 are now in the application. Claims 1-23 and 43-45 have been amended. Claim 46 has been added.

The election of Group I including claims 1-23 and 43-45 is affirmed. This affirmation is made pursuant to the request in the final paragraph on page 2 of the Office action.

In the penultimate paragraph on page 3 of the Office action, the Examiner suggested clarifications to claims 1 and 20. In particular, the Examiner suggested that the phrase "at least partially recompressed" was unclear. Claims 1 and 20 have been amended and the phrase has been removed.

Similarly, the Examiner suggested changes to claim 13. Claim 13 has been amended to clarify the claim and provide all of the terms with antecedent basis in claim 1.

In addition, the Examiner suggested changes to claim 23. Claim 23 has been amended. Claim 23 is intended to describe a coating around the body. The coating does not completely cover the body. Rather, the coating is incomplete and the areas of the body that are not covered can be used to form electrical contacts.

In the second paragraph on page 4 of the above-identified Office action, the Examiner has rejected claim 21 as being indefinite under 35 U.S.C. § 112, second paragraph. More specifically, the Examiner has stated that it is unclear how a resin impregnated body can have resin system only in regions close to the surface or in a part of the body. Claim 21 has not been amended because it was definite in its original form for the following reasons.

According to McGraw-Hill's dictionary of scientific and technical terms "to impregnate" means to force a liquid substance into the spaces of a porous solid in order to change its properties. Industry understanding understands this not to mean that necessarily all of the pores in all regions of the body are completely filled. In fact, the degree of uptake of the liquid depends on many factors, i.e. application of pressure or vacuum, duration of the application, wetting behavior of the liquid to the solid, pore structure of the solid, contact area between solid and liquid, etc.

Therefore, one with ordinary skill in the art would know that, by lowering the impregnation time, the less deep the resin can penetrate into the body and that, when only a part of the body to be impregnated is brought into contact with an impregnation liquid (i.e. by partly dipping the body into the liquid), the

resin content within this is part would be higher than in other regions of the body not dipped into the liquid.

Accordingly, the claims meet the requirements of 35 U.S.C. § 112, second paragraph. Should the Examiner find any further objectionable items, counsel would appreciate a telephone call during which the matter may be resolved. The changes are neither provided for overcoming the prior art nor do they narrow the scope of the claim for any reason related to the statutory requirements for a patent.

In the final paragraph on page 4 of the Office action, the Examiner rejected claims 1-2, 5, and 19 as being fully anticipated by Olstowski et al. (U.S. 3,573,122) under 35 U.S.C. § 102(b). As will be explained below, the claims were patentable over the cited art in their original form and the claims have, therefore, not been amended to overcome the references.

Before discussing the prior art in detail, a brief review of the invention as claimed is provided. Claim 1 calls for, *inter alia*, a body having the following features:

expanded graphite recompressed to a bulk density between 0.1 and 1.8 g/cm<sup>3</sup>;

said graphite containing a solvent-free, low-viscosity, storage-stable resin system selected from the group consisting of isocyanates and epoxy resins

with coreactants thereof and polymers obtained by curing at least one of said resin systems (Emphasis added by Applicants.).

According to the present invention, a body of expanded graphite with a bulk density between 0.1 and 1.8 g/cm<sup>3</sup> (p.3 I.13-18) is impregnated with a solvent-free liquid resin. The resin can be isocyanates or epoxy resins (each with their co-reactants). The resulting resin content of the graphite body is at most 50 wt% (see especially claims 16 and 46) and preferably between 5 and 25 wt% (see especially claim 17). Preferably, the epoxy resin contains > 50 wt% bisphenol(A)diglycidyl ether (epoxy resin system 1, p.10 I.4 ff.) or bisphenol(F)diglycidyl ether (epoxy resin system 2, p.10 I.18 ff.) and between 25 and 50 wt% methylhexahydrophthalic anhydride as the co-reactant.

In Example I, Run C, of Olstowski's invention, a body of less-densified expanded graphite is impregnated with a liquid resin including bisphenol (A) diglycidyl ether and the co-reactant diethylene triamine in a weight ratio of 1:10. The bulk density of the expanded graphite body is only 0.85 lb/ft<sup>3</sup> = 0.0136 g/cm<sup>3</sup> (col. 8 I.37 Run C(a)) or 1.62 lb/ft<sup>3</sup> = 0.026 g/cm<sup>3</sup> (col.8 I.60 Run C(b)).

Thus, in Olstowski, the graphite body to be impregnated is much more porous, therefore the entering of the resin into the

voids of the graphite should be much easier, viscosity of the impregnation agent should be less critical and finally a higher uptake of resin is obtained.

Indeed the bodies prepared by Olstowski contain only 1.86 wt% graphite (col.8 I.54 Run C(a)) or 4.4 wt% graphite (col.8 I.64 Run C(b)). Thus, the resin content is above 95 wt% which is much higher and by no means "similar" to the values specified in claims 16-18 of the present invention; contrast the final paragraph on page 5 of the Office action, continuing to page 6. In paragraph (d) of claim 1 of Olstowski (col.17 I.12), a resin content between 60 and 99.95% of the total structure is claimed. Thus, the Examiner's assertion in the last paragraph of page 5 of the Office Action that Olstowski does not disclose the amount of resin in the impregnated body is incorrect.

The differences between the present and Olstowski's invention regarding structure, composition, and electrical conductivity of the claimed bodies will be even more clearly from the table given below.

EXAMPLE NO.	Thick- ness mm	Resis- tance mOhm	Resis- tivity mOhm cm	Resis- tivity Ohm cm	Resis- tivity Ohm inch	Density g/cm <sup>3</sup>	Density lb/ft <sup>3</sup>	resin content wt %	graphite content/ wt %
1 epoxy resin 1 Table 1, p. 28	1	0.52	102.05	0.10205		1		15	
1 epoxy resin 2 Table 1, p. 28	1	0.39	76.5375	0.076538		1		14.6	
3a	0.25	0.24	188.4	0.1884		1		29.4	
3b	1	0.43	84.13875	0.084388		1		16	
3c	2	0.57	55.93125	0.055931		1		11.4	
3d	4	0.85	41.703125	0.041703		0.5		38.9	
Olstowski Run Ca				0.95504	0.376	0.013	0.85	98.14	1.86
Olstowski Run Cb				0.1397	0.055	0.026	1.62	95.6	4.4

Therefore, while the resin system used for the impregnation is similar, the resin system is not identical to the invention as claimed.

Regarding the viscosity and storage stability of Olstowski's resin compared to the present invention, it is well known to a person skilled in the art that epoxy resins with aliphatic amine hardeners like diethylene triamine are of low viscosity which is advantageous for the impregnation process. It is further known that they are fast curing, resulting in a brittle bond. See EXHIBIT A, which is pages from a brochure of epoxy resin manufacturer Bakelite. Another disadvantage is the low pot life.

According to the "Tutorial on Composite Polymer Molding" provided 1999 by the Intelligent Systems Laboratory of

Michigan State University (see website [http://islnotes.cps.msu.edu/trp/back/cur\\_epox.html](http://islnotes.cps.msu.edu/trp/back/cur_epox.html)), anhydridic curing agents are advantageous over amines because of their lower reactivity, lower exothermy, and longer pot life.

In contrast to the Examiner's assertion in the second paragraph of page 6 of the Office action, the different amounts of resin the networks in both materials (see claim 20 of the present invention) patentably distinguish the claimed product from the prior-art. Due to the much higher resin content, the graphite network in Olstowski's impregnated body should be much more wide-meshed, i.e. with less connection points. This different network structure will have a strong influence on product properties like thermal and electrical conductivity: the less connection points in the graphite network, the lower the thermal and electrical conductivity.

Regarding the intended use of the impregnated graphite body given in claims 43-45, it should be clear from the details outlined above that they are indeed based on a structural difference in comparison with the prior art of Olstowski. Regarding the claimed use as an electrical conductive element (cl. 44) in a fuel cell, the electrical conductivity is a crucial feature. Olstowski discloses specific bulk resistivities of 0.376 Ohm inch = 0.9554 Ohm cm (col.8 I.56

Run C(a)) and 0.055 Ohm inch = 0.14 Ohm cm (col. 8 I.66 Run C(b)). For comparison, specific bulk resistivities of the bodies of the present invention were calculate from the measured resistances given in the tables 1 and 3, the sample thickness given in the tables 1 and 2 and the electrode area (50 mm diameter, see p.26 I.9). The obtained resistivities of most of the samples vary between 0.04 and 0.1 Ohm cm. Only the value of the very thin sample 3a deviates from this range, but its resistivity of 0.19 Ohm cm is still much lower than that of the less conductive sample of Olstowski. Due to its lower conductivity, the bodies of Olstowski's invention would be much less capable of performing the intended use as a conductive element in a fuel cell.

It is well known to a person skilled in the art that the electrical conductivity and the thermal conductivity are closely related to each other, and therefore a body with a lower electrical conductivity has also a lower thermal conductivity than an other body with a less higher electrical conductivity. Thus, the body of Olstowski should also be much less capable of performing the intended use as a heat-conducting element (cl. 45) than the body of the present invention.

In the second paragraph on page 7 of the Office action, the Examiner rejected claims 4 and 13 as being unpatentable over



Olstowski et al. in view of Amano et al. (U.S. 5,679,730) under 35 U.S.C. § 103(a). The claims have not been amended because they are believed to be patentable in the original form for the following reasons.

While the Examiner is correct that Amano discloses the use of methylhexahydrophthalic anhydride as a curing agent for epoxy resins, its use as a hardener was merely included in a dependent claim.

More importantly, combination of the curing agent disclosed by Amano et al. with the teaching of Olstowski et al. would by no means result in the impregnated graphite body of the present invention because of the lower bulk density of the expanded graphite and the higher resin content of the impregnated body in Olstowski's invention resulting in different characteristics than those of the impregnated graphite body of the present invention.

Furthermore, Amano's teaching is related to an epoxy-resin composition with improved thixotropy and low stringiness as necessary for the use in adhesives. The resin might contain expanded graphite dispersed therein as a filler. According to the object of the invention of the instant application, expanded graphite is impregnated with a resin in order to obtain bodies with corrosion resistance, electrical and

thermal conductivity and gas tightness (see page 8).

Therefore, a person skilled in the art of impregnation would not seek a suitable impregnation agent in the field of resin compositions containing expanded graphite or other fillers and adhesives based on such resins to which Amano's patent belongs.

- Regarding isocyanate resins, Amano discloses a resin composition comprising (col. 2 I. 6-10):
- An epoxy resin
- A thixotropy-imparting agent
- A filler (e.g. expanded graphite powder)
- Water; and
- A polycarbodiimide resin.

The polycarbodiimide resin is obtained from organic isocyanates (col. 2 I.55/56) and has a structure  $-R-N=C=N-$  (col. I, 66) with R being an isocyanate residue, i.e. an organic diisocyanate residue where two isocyanate groups are removed from one molecule of an organic diisocyanate, col.3 I.2-4) and which might have terminal isocyanate groups.

Thus, the role of isocyanates in Amano's and the present invention is completely different. In the present invention, isocyanate in combination with its co-reactant is used as an

alternative impregnation age beside the epoxy resin system.

In Amano's invention, organic diisocyanate is the precursor of the polycarbodiimide resin (which might still contain terminal isocyanate groups) which is an only a minor component in a epoxy-resin based composition. So, in the field of isocyanates there is very few relation between Amano's and the present invention.

It is true that Olstowski also discloses polyurethane as suitable polymeric substance for the impregnation of expanded graphite. Polyurethane is the product of the polycondensation of a polyol and an organic diisocyanate. MDI is one suitable diisocyanate among others. However, even when conceding that Olstowski has implicitly disclosed the use of the impregnation agent mentioned in claim 11 of the present invention, the product of the present invention cannot be obtained because of the lower bulk density of the expanded graphite and the higher resin content of the impregnated body in Olstowski's invention. These characteristics distinguish the impregnated graphite body of the present invention.

The same applies to the Examiner's objection to claim 3. Even when replacing the bisphenol(A)diglycidyl ether in Olstowski's invention by bisphenol(F)diglycidyl ether, the product of the present invention cannot be obtained because of the lower bulk density of the expanded graphite and the higher resin content

in Olstowski's invention, which necessarily lead to different characteristics than those of the impregnated graphite body of the present invention.

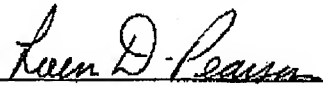
In the final paragraph on page 8 of the Office action, the Examiner rejected claims 21-23 as being unpatentable over Olstowski et al. Claims 21-23 ultimately depend on claim 1 and are patentable for the reasons previously discussed relating to claim 1.

In view of the foregoing, reconsideration and allowance of claims 1-23 and 42-46 are solicited. In the event the Examiner should still find any of the claims to be unpatentable, please telephone counsel so that patentable language can be substituted.

Petition for extension is herewith made. The extension fee for response within a period of one month pursuant to Section 1.136(a) in the amount of \$110 in accordance with Section 1.17 is enclosed herewith.

Please charge any other fees that might be due with respect to Sections 1.16 and 1.17 to the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099.

Respectfully submitted,

  
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For Applicants

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LDP:cgm

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